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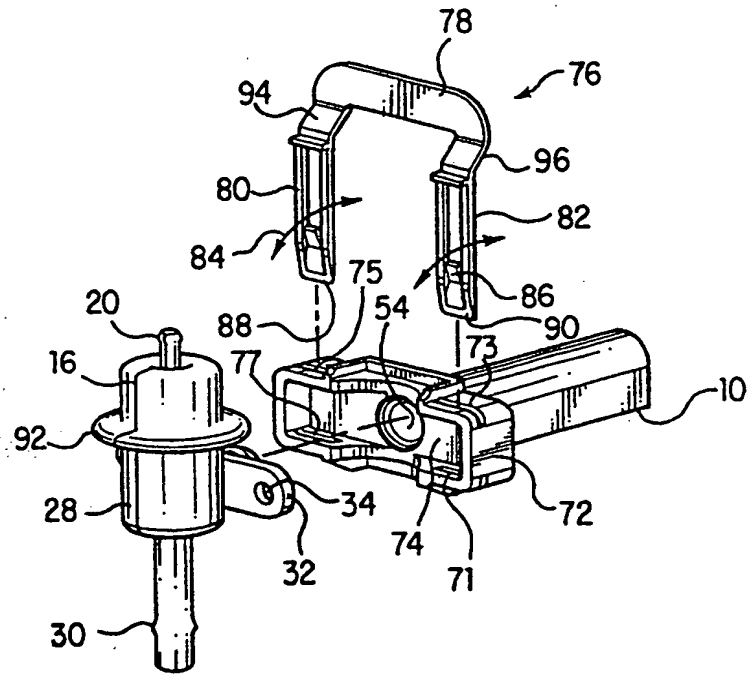
(71) Applicant: SIEMENS CANADA LIMITED [CA/CA]; 2185 Derry Road West, Mississauga, Ontario L5N 7A6 (CA).

(72) Inventors: MURPHY, Kevin, A.; 39526 Salvatore, Sterling Heights, MI 48313 (US). PANNUNZIO, Daniel, F.; P.O. Box 342, Ruthven, Ontario N0P 2GO (CA).

(74) Agent: MacRAE & CO.; P.O. Box 806, Station B, Ottawa, Ontario K1P 5T4 (CA).

(54) Title: DEVICE FOR MOUNTING A PRESSURE REGULATOR ON A PLASTIC FUEL LINE



(57) Abstract

Various types of fuel pressure regulators (16) are secured to a plastic fuel rail (10) utilizing a number of fastening elements. These fastening elements include a plurality of flexible clips (76) for securing the fuel pressure regulator within a retaining member (72) or retaining cup. Additionally, a number of twist lock caps are also used to secure the pressure regulator in place within a mounting cup. Furthermore, a living hinge fastening device is also used to secure the pressure regulator in place.

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DEVICE FOR MOUNTING A PRESSURE REGULATOR ON A PLASTIC FUEL LINE

CROSS-REFERENCE TO RELATED APPLICATION

This application expressly claims the benefit of earlier filing date and right of priority from the following co-pending patent applications: U.S. Provisional Application Serial No. 60/052,694, (Attorney Docket 97 P 7673 US), entitled "Methods For Mounting Fuel Pressure Regulators" filed 16 July 1997 and U.S. Provisional Application Serial No. 60/052,693, (Attorney Docket 97 P 7674 US), entitled "Methods For Mounting Fuel Pressure Regulators," filed on 16 July 1997. Both cited patent applications are expressly incorporated in its entirety by reference.

BACKGROUND OF THE INVENTION

A current industry trend in the automotive industry is to mold various components of an engine from composite materials, such as plastic, instead of from metallic materials which was the standard practice. However, if not all of the components were manufactured from the composite material, a problem resulted when metallic components were to be connected to composite components at the mounting interface. Producing a mounting interface and retention mechanism for a pressure regulator on the fuel passage posed mold tooling challenges above those encountered for a separate fuel rail. Small complex details that may be achieved in a mold for a fuel rail are of a significantly greater concern on large molds that produce an intake manifold.

U.S. Patent 5,390,638, issued to Hornby, describes a fuel rail assembly in which metallic tubes are connected to main plastic fuel tubes. The main fuel tubes 52, 54 have been produced by injection molding from suitable material for handling pressurized liquid fuel, such as gasoline. Main fuel tube 54 includes an integral socket 60 into which a conventional fuel pressure regulator 62 is inserted and retained in a secure, sealed manner. The retention means includes a retention clip 194 comprising a flat,

somewhat U-shaped fork 196 having tines 198. An aperture tongue 200 is spaced from, but generally parallel with the fork 196. Cup 60 contains a plurality of slits into which the tines are inserted. These tines along with the tongue 20 are employed to retain the fuel regulator in place.

U.S. Patent 5,577,478, issued to Tuckey, illustrates a fuel pressure rail assembly constructed from metallic material into which a fuel pressure regulator is secured. A spring clip 20 having a horseshoe shaped resilient band 130 is constructed and arranged to snap through the pressure regulator skirt 86 and flange 88 to secure the regulator in place.

U.S. Patent 5,094,211, issued to Mahnke et al, relates to a device for mounting a fuel regulator 32 within a cup section 52 of an automotive fuel rail. An upper mounting flange 86 is used to secure the fuel regulator within the cup 50.

U.S. Patent 5,070,844, issued to Daly, illustrates a fuel rail assembly 10 comprising a plurality of rigid composite injector-receiving socket members 12 connected together in a straight line by rigid straight metallic tubes 14. Hairpin clips 54 assist in the connection of the metallic tubes 14 to the socket members 12.

Although the patent to Hornby et al describes a device in which a fuel pressure regulator is secured into a plastic fuel rail by the utilization of a spring clip, it was believed necessary to develop additional devices and methods of securing the fuel pressure regulator to a molded plastic fuel rail as described in the present invention.

SUMMARY OF THE INVENTION

Various deficiencies in the prior art are addressed by the present invention directed to various methods and devices for securing integral and stand alone configurations for return and returnless flow operation pressure regulators to fuel rails molded by composite metallic material. However, it is to be noted that the means and methods of attaching the fuel pressure regulator to the fuel rails can also be fabricated from

metallic material. Although the appearance of these connections might change, the function would be retained.

When used with stand alone fuel pressure regulators, various devices can be used to secure the regulator to the end of the composite fuel rail. For example, various types of clips can be used to secure a bracket attached to the fuel pressure regulator to the end of the fuel rail. A barbed end clip that directly withstands the fuel pressure at loading can be used as well as a molded version having a strap spanning two barbs. A shear clip design engaging a slot molded into the fuel passage having flexible tabs at the ends thereof would provide a locking feature. Furthermore, a living hinge can be employed encircling both the fuel pressure regulator as well as the end of the fuel rail.

Additionally, the stand alone fuel pressure regulator can be secured to the end of the fuel rail using a locking pin to secure the fuel regulator within a slot molded into a retaining member provided at the end of the fuel rail. The fuel regulator is initially inserted into the retaining member by a twisting motion. Other securing mechanisms would include spring action devices molded within the manifold. It is noted that the retaining feature must limit rotation after the regulator has been installed.

When used with integral fuel pressure regulators, a cap can be attached to the fuel passage by engaging a series of slots with corresponding features on the fuel passage. This cap would include various engaging members, such as small lugs for engaging ribs directly molded onto the retaining member connected to the fuel rail. Similar to the stand alone fuel regulator, clips could also be used to hold the pressure regulator properly in place.

The foregoing features and other objects will become apparent from a reading of the following specification in connection with the drawings, wherein like parts have the same index numerals.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated herein and constitute part of this specification, include one or more presently preferred embodiments of the invention, and together with a general description given above and a detailed description given below, serve to disclose principles of the invention in accordance with a best mode contemplated for carrying out the invention.

FIG. 1 is a perspective view of an intake manifold with an integral fuel passage showing a typical pressure regulator in position;

FIG. 2 is an exploded diagram of a stand alone fuel pressure regulator to be connected to a fuel rail;

FIG. 3 is a perspective view of the pressure regulator of FIG. 2 connected to the fuel rail;

FIG. 4 is a view showing two devices for fastening the regulator shown in FIG. 2 to the fuel rail;

FIG. 5 is an exploded view of another embodiment of a device for connecting a stand alone pressure regulator to a fuel rail;

FIG. 6 is a perspective view of the pressure regulator of FIG. 5 connected to the fuel rail;

FIG. 7 is a view of one of the fastening elements shown in FIG. 5;

FIG. 8 is an exploded view of another embodiment of the element fastening the stand alone fuel regulator to the fuel rail;

FIG. 9 is a perspective view of the regulator-fuel rail assembly of FIG. 8;

FIG. 10 is an exploded view of another embodiment showing a stand alone pressure regulator-fuel rail connection assembly;

FIG. 11 is a perspective view showing the connection of the regulator of FIG. 10 to the fuel rail;

FIG. 12 is an exploded view showing several fastening elements for connecting an integral pressure regulator to a fuel line;

FIG. 13 is a detailed view of one of the fastening elements of FIG. 12;

FIG. 14 is a detailed view of the second fastening element of FIG. 12;

FIG. 15 is a perspective view showing the integral pressure regulator connected to the fuel rail;

FIG. 16 is an exploded view showing the integral pressure regulator connected to the fuel rail by another embodiment;

FIG. 17 is a perspective view of the pressure regulator of FIG. 16 connected to the fuel rail;

FIG. 18 is an exploded view of the integral pressure regulator connected to the fuel rail by another embodiment;

FIG. 19 is a perspective view showing the integral pressure regulator of FIG. 18 connected to the fuel rail;

FIG. 20 is a perspective view of a demand-type returnless integral pressure regulator connected to the fuel line;

FIG. 21 is a sectional view taken through lines B-B of FIG. 20;

FIG. 22 is a perspective view taken through lines A-A of FIG. 20;

FIG. 23 is an exploded view showing a demand-type integral returnless pressure regulator connected to a fuel line by one of two fastening elements;

FIG. 24 shows a perspective view of the connection illustrated in FIG. 23;

FIG. 25 shows an exploded view of a demand-type integral returnless pressure regulator connected to a fuel line by another embodiment;

FIG. 26 is a perspective view of the connection illustrated in FIG. 25;

FIG. 27 is an exploded view showing a demand-type integral returnless regulator connected to a fuel rail by another embodiment;

FIG. 28 shows the connection illustrated in FIG. 27;

FIG. 29 is an exploded view of the demand-type integral returnless fuel regulator connected to a fuel line by another embodiment;

FIG. 30 is a perspective view shown in the combination illustrated in FIG. 29;

FIG. 31 is a sectional view along lines C-C of FIG. 32;

FIG. 32 is an exploded view showing the demand-type integral returnless pressure regulator connected to a fuel line by another embodiment; and

FIG. 33 is a perspective view of the combination illustrated in FIG. 32.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

While the present invention will be described hereinafter in connection with preferred embodiments thereof, it will be understood that it is not intended to limit the invention to those embodiments. On the contrary, it is intended to cover all alternatives, modifications, and equivalents as may be included in the spirit and scope of the invention as defined by the appended claims.

FIG. 1 illustrates a typical intake manifold **14** and was included to show the positioning of a pressure fuel regulator **16** with respect to a fuel rail **10**. Although the fuel rail **10** is constructed from a composite material such as plastic, this need not be the case and the teaching of the present invention can be extended to manifold castings or separate fuel lines of various construction methods. A plurality of connectors **12** are included through which metering valves or injectors deliver on a suitable electric command, the quantity of fuel necessary to form the correct pressurized mixture to supply to an internal combustion engine. The fuel pressure regulator **16** sits within a cup **18** directly molded or connected to the fuel rail **10**. The types of fasteners used to retain the pressure regulator **16** firmly within the cup **18** will be explained with respect to the remaining figures of the present invention. The fuel rail or line **10** is connected to a fuel pump through

a line 22 by a standard quick connection 24, as well as other conventional connection methods. The regulator 16 may communicate with the intake manifold vacuum via a conduit (not shown) coupled to a nipple 20 associated with the regulator's upper housing. Although FIG. 1 illustrates the positioning of an integral fuel pressure regulator, it is noted that any type of fuel regulator such as a stand alone fuel regulator or a demand-type integral returnless regulator could also be utilized.

The present invention will be described with respect to both integral and stand alone fuel pressure regulators. A stand alone configuration has a pair of ports for fuel inlet and return on a body that contains the fuel. A significant portion of the body holds pressurized fuel in the interior while the exterior is exposed to the atmosphere. Generally, the stand alone configuration has a bracket attached to the housing that serves as the interface to mounting surfaces on other components. It can be mounted anywhere, including remotely from the fuel rail or engine. This is contrasted with an integral configuration. The integral configuration also has inlet and return ports. However, these ports are submerged in the cavity of a mating part that has corresponding passages. The body structure containing the pressurized fuel is almost entirely submerged inside the mating part cavity. It is not able to be located remotely from the fuel rail unless it has an additional piece that covers the passages. A separate retaining mechanism, usually a clip, is necessary to hold the regulator in a cavity.

Both the stand alone configuration as well as the integral configuration could operate as either a return system or a returnless system. The return system continually recirculates the fuel. More fuel than is necessary for engine consumption circulates through the fuel rail, with the excess being returned to the tank for continued usage. A returnless system requires that all fuel entering the fuel rail be consumed. This system can have a pressure regulator that still returns excess fuel to the fuel tank. In this situation, the fuel is routed to the rail before the regulator as a spur off the main fuel line. Any pressurized fuel on that spur must enter the engine through the fuel rail. All bypass fuel exiting the regulator returns to the fuel

tank. A special version of this is the demand-type returnless configuration. This configuration requires that all fuel leaving the regulator be consumed by the engine. It works by providing just enough fuel into the rail to ensure that it is full and at pressure. Any time fuel is consumed, the regulator opens to allow more fuel to enter.

FIGS. 2, 3 and 4 illustrate a first embodiment of the present invention in which a stand alone pressure regulator **16** is attached to the rail **10** utilizing either a conventional threaded screw **40** or a thread forming or self-tapping screw **36**. The pressure regulator **16** includes an upper housing **26** as well as a lower housing **28**. A bracket **32** is affixed to the lower housing **28** of the pressure regulator **16**. This bracket is provided with two holes **34**. The regulator **16** is secured to the fuel rail **10** utilizing the bracket **32** cooperating with two holes **48, 50** provided on a retaining member **44** directly molded onto the fuel rail **10**. A fuel communications bore **54** is directly in communication with an inlet attached to the lower housing **28**. It is noted that the bracket **32** can surround this fuel outlet or two separate brackets can be utilized. A fuel inlet **30** connecting the pressure regulator to the fuel tank is also connected to the lower housing **28** of the fuel regulator **16**.

If a conventional screw **40** provided with a threaded shank **42** is used to affix the bracket **32** to the fuel rail retaining member **44**, the corresponding hole **46** of the retaining member **44** would have a bore having corresponding threads therein. Additionally, a rigid plastic surface **48** is also directly molded to the retaining member **44**. Conversely, if a thread forming screw **36** having a shank **38** is employed, the threads provided within the hole **50** would be formed when the screw **36** is screwed through the bracket **34** into hole **50**. In this instance, obviously the material of the shank **38** must be stronger than that of the hole **50**.

FIG. 3 illustrates the stand alone pressure regulator **16** directly connected to the fuel line **10** using either the conventional screw **40** or the thread forming screw **36**, or a combination of the two screws shown in FIG. 4.

FIGS. 5, 6 and 7 illustrate a second embodiment of the present invention in which a barbed fastening member **56** is used to secure the stand alone pressure fuel regulator **16** to a retaining member **44** molded to the fuel line **10**. The fastener **56** includes a plastic band **58** having ends **60, 62** offset from the band **58**. Attached to each of the ends **60, 62** would be a single flexible barb **64, 66** respectively.

Each of these barbs is provided with flexible tabs **68, 70** as shown in FIG. 7. The barbs including the flexible tabs **68, 70** are pressed through the holes **34** in the bracket **32** and are then inserted into the holes **46, 50** of the retaining member **44**. The tabs **68, 70** collapse during insulation and spread out once they enter the holes **46, 50** to secure the pressure regulator in place. It is noted that a metallic version of the clip could be constructed using a band and two separate rivet clips. Both the plastic and metallic configuration are particularly efficient since the pressure regulator can be installed without the use of any tools. Alternatively, two separate clips could be used without employing the band **58**. This embodiment would be constructed to directly withstand the fuel pressure loading of the regulator.

FIG. 6 illustrates the pressure regulator **16** as it is installed into the molded retaining member **44** of the fuel rail **10**.

FIGS. 8 and 9 illustrate yet another embodiment of the present invention for securing a stand alone fuel pressure regulator **16** to a fuel line **10**. In this instance, a plastic retaining member **72** is molded to the end of the fuel line **10**. This member **72** is provided with a recessed interior area **74** into which the bracket **32** connected to the lower housing **28** of the regulator **16** would be inserted. Two pairs of slots **71, 73, 75** and **77** are provided in the retaining members **72**. A forked shear clip **76** includes two parallel leg portions **80, 82** connected by a band portion **78** through angled portions **94, 96**. Flexible tabs **84, 86** are provided within a slot in each of the legs **80, 82** close to the ends **88, 90** thereof. These tabs provided the locking feature for the fuel regulator **16**. Once the bracket **32** is inserted within the recessed interior **74** of the retaining member **72**, the shear clip **76** is slid through the

slots **71, 73, 75** and **77** of the retaining member **72** and the bracket **32** thereby retaining the fuel pressure regulator **16** in place as is shown in FIG. 9.

It is noted that the stand alone configuration includes a lip **92** extending around the bottom periphery of the top housing **26** of the regulator. Due to this configuration, angled portions **94** and **96** offset the plane of the legs **80, 82** from the plane of the band **78**. Once the flexible tabs **80, 82** are slid past the bottom surface of the retaining member **72**, these tabs would move in the direction shown by the arrows in FIG. 8 which would be normal to the plane of the clip and thereby retain the regulator **16** in the retaining member **72**. It is also noted that a similar function could be achieved by a motion in the plane of the shear clip **76**.

FIGS. 10 and 11 illustrate yet another embodiment in which a stand alone pressure regulator **16** is connected to a plastic fuel line or rail **10**. In this embodiment, a plastic retaining member **100** is molded to the end of the fuel line **10**. Slots **102** and **104** are provided within the retaining member **100.** Slot **102** is provided with a bottom support member **108** and slot **104** includes a top support member **106**. These slots are adapted to receive each end of the bracket **32**. A locking pin **110** having flexible barbs **112** on its end are used to secure the pressure regulator **16** to the retaining member **100** after the bracket **32** is properly inserted within the slots **102** and **104**. The barbs **112** would be used to positively secure the bracket in place. Although it is noted that other types of retaining members can be employed for this purpose. To properly receive the fuel pressure regulator **16** in place, the regulator **16** is rotated on its fuel passage axis as shown by arrows **114, 116** and **118**. At this point, the fuel pressure regulator **16** is pushed into the fuel communication bore so that one end of the bracket **32** is provided above the slot **102** and the second end is provided under the slot **104**. The fuel pressure regulator **16** is then rotated in the opposite direction on its axis to engage the bottom support member **108** as well as the top support member **106** of the slots **102** and **104**. At this point, the barbed locking pin **110** is

inserted into one or more of the bracket holes to secure the fuel pressure regulator **16** against rotation as shown in FIG. 11.

FIGS. 12, 13, 14 and 15 illustrate two clips for retaining an integral pressure regulator **120** within a plastic retaining cup **122** molded to and attached to a fuel rail **10** by a plastic support **124**. Fastening members **130, 132** represent various push on forked shear clips used to retain the pressure regulator **120** within the retaining cup **122**. Clip **130** is provided with two flexible legs **134, 136** connected together by a head portion **137**. The end portion of each of the legs **134, 136** includes locking members **140, 138** respectively. These locking members are shown in more detail in FIG. 13 and move in the plane of the clip as shown by arrows **133, 135,** allowing locking members **138** to deflect in the plane of the clip. Retaining cup **122** is provided with two slots **126, 128** through which the legs **134, 136** as well as the retaining members **138, 140** would pass. Therefore, when the integral pressure regulator **120** is inserted within the retaining cup **122** and the legs **134, 136** of the retaining member **130** pass through slots **126** and **124**, the inner surfaces **127, 129** would be maintained against the outer surface of the integral pressure regulator **120** as illustrated in FIG. 15.

The second plastic retaining member **132** includes flexible legs **142, 144** connected by a band **146**. As shown in FIG. 14, each of the legs includes an undercut portion **148** adapted to cooperate with retaining cup **122** to retain the integral pressure regulator **120** within the cup **122** after the retaining member **132** is inserted through the slots **126, 128**. Once the undercut portions **148** clear their respective slots **126, 128**, they would also move in the plane of the clip as shown by arrows **150, 152** and would abut the end surface of the retaining cup **122** to properly maintain the integral pressure regulator **120** therein.

FIGS. 16 and 17 illustrate a means for fastening the integral fuel pressure regulator **120** to a fuel rail **10** employing a fastening clip **168** and a retaining cup **154** attached to the fuel rail **10** via a mounting device **156**. The retaining cup **154** is provided with a first pair of slots **160, 162** as well as a

second pair of slots **164, 166** all provided on an upper housing portion **158** of the cup **154**. The clip **168** includes two flexible legs **170, 172** connected by a band portion **174**. Similar to the other fastening devices used according to the present invention, the clip **168** can be manufactured from a plastic composite material or a metallic material. Each of the legs **170, 172** is provided with a flexible end portion **176, 178** respectively. These end portions deflect transverse to the plane of the clip as indicated by arrows **180, 182**. Each of the end portions **176, 178** is provided with an undercut portion **184, 186** respectively. Therefore, once the integral pressure regulator **120** is inserted within the retaining cup **154**, the legs **170, 172** of the clip **168** would be inserted through slots **160, 162** as well as **164, 166** respectively. Once the undercut portions **184, 186** extend through slots **162, 166**, the legs would deflect upward thereby allowing the undercut portions **184, 186** to contact the outer surface of the top portion **158** of cup **154**, thereby holding the regulator **120** firmly in place as illustrated in FIG. 17.

FIGS. 18-22 illustrate an integral fuel pressure regulator **20** attached to the fuel rail **10** utilizing a twist cap **194** lock. It is noted that the demand-type fuel regulators could also be employed. FIGS. 18-20 illustrate the embodiment in conjunction with fuel pressure regulator **120** and FIGS. 21-22 employ fuel pressure regulator **202**. Retaining member **20** is molded directly to the end of the fuel rail **10** and includes a plurality of ribs **192** evenly spaced on its periphery. The cap **194** as shown in both FIGS. 18 and 20 includes one or more gripping surfaces **196** for twisting the cap onto the retaining cup **190** as well as a plurality of dimples **200** provided on the inner surface of the cap **194**, each of the dimples corresponding to one of the ribs **192**. As shown in more detail in the sectional views shown in FIGS. 21 and 22, the ribs **192** in combination with its respective dimple **200** would lock the fuel pressure regulator **202** in place after it has been twisted into the closed position as shown in FIGS. 19 and 20. In this position, the cap **194** will remain firmly in place and would not move from this closed position to an

open position. Similar to all of the fastening devices described in this invention, this cap can be installed without the use of any tools.

FIGS. 23 and 24 illustrate a demand-type integral returnless fuel pressure regulator **202** mounted at the end of a molded plastic fuel rail **10**. Reference numeral **204** refers to a fuel inlet connected to the fuel tank. A retaining cup **206** is molded to the end of the fuel rail **10** and includes two slots **208, 210** on its periphery. In one embodiment, a fastening clip **212** having flexible legs **214** and **216** is used to secure the fuel pressure regulator **202** within the mounting cup **206**. Flexible tabs **218** and **220** are provided on each end of the fastening clip **212** and deflect in the plane of the clip as shown by arrows **222** and **224**. In this manner, once the fuel pressure regulator **202** is inserted within the retaining cup **206**, the legs **214, 216** of clip **212** are inserted through their respective slots **208, 210**. Once tabs **218, 220** pass out of the retaining cup **206**, they will move in the direction shown by arrows **222, 224** to secure the regulator **202** in place. A second option utilizes a flexible plastic or metallic clip **226** having legs **228, 230** connected by a band member **232**. Similar to the clip **212**, the legs **228, 230** of flexible clip **226** pass through the slots **208, 210** of the retaining cup **206** to secure the regulator **202** in place as shown in FIG. 24. A slot **236** is provided at the bottom of the retaining cup **206** to allow the line **204** to be properly inserted when the regulator **202** is secured in place.

FIGS. 25 and 26 illustrate a device for securing a demand-type integral returnless pressure fuel regulator **202** to a plastic fuel rail with a plastic retaining cup **238** molded to one end of the line **10**. A flexible clip **248** similar in many respects to the clip illustrated in FIG. 16 is used to secure the pressure regulator **202** in the retaining cup **238**. In this instance, the retaining cup is provided with slots **240, 242, 246** and **248** through which legs **250, 252** of the clip **248** would pass. Each of the legs is provided with flexible end portions **254, 256** which deflect transverse to the plane of the clip as shown by arrows **258, 260**. A slot **262** is provided to accommodate line **204**. In this matter, the regulator **202** is secured in place as illustrated in FIG. 26.

FIGS. 27 and 28 are directed to another means for fastening the demand-type integral returnless regulator **202** to a plastic fuel line **10** having a plastic retaining cup molded to the end of the line **10**. The retaining cup includes slots **264, 266, 268** and **270** provided around the periphery of the retaining cup **262**. A tab **272** is also provided around the periphery of the cup **262**. The plastic fastening device **274** includes a pair of legs **276, 277** as well as a flexible arch portion **278** connected to the top of the clip **274**. The arch portion includes a deflectable member **280** which deflects transverse to the plane of the clip as shown by arrows **282**. Once the regulator **202** is inserted into the retention cup **262**, the legs **276, 277** would be inserted through the four slots **264, 266, 268** and **270**. At this point, the portion **280** would deflect in a plane transverse to the plane of the clip as shown by arrow **282** and would be locked against the tab **272** thereby securing the regulator **202** in place as shown in FIG. 28.

FIGS. 29, 30 and 31 show the use of an axial snap clip for securing a demand-type integral returnless fuel pressure regulator **202** in place within a plastic retaining cup **286** molded to the end of the fuel rail **10**, the plastic retaining cup including a slot **288** provided for the reception of the input line **204**. The retaining cup **286** is provided with a raised surface **287** extending around the periphery of the retaining cup **286**. A plastic or metallic snap cap **290** is used to straddle the pressure regulator **202**, in a manner in which an increased bearing area limits the contact stress on the plastic retaining cup **286**, thereby reducing the tendency to creep. The cap **290** is provided with a plurality of support tabs **294**, each of the bearing members **292** are provided with scalloped recesses **296**. The regulator **202** is inserted within the retaining cup **286** and the cap **290** is then snapped over the exterior surface of the retaining cup with the tabs **294** bearing against the raised periphery **287** as shown in FIG. 30 as well as FIG. 31.

FIGS. 32 and 33 illustrate another method and device for securing a demand-type integral returnless fuel pressure regulator **202** to a plastic fuel line **10** having a plastic retaining cup **300** molded to its end. The

retaining cup **300** is provided with a rim **302** extending around its entire periphery with the exception of slot **322** used to accommodate the line **204** of the regulator **202**. The fastening device **303** contains split body portions **304** and **305** connected together by a living hinge **306**. A slot **307** is provided is section **305** and a second slot **309** is provided within section **304**. An end **310** of section **305** is provided with a flexible tab **312**. End **308** of side **304** is provided with a recess **314**. It is noted that this fastening device **303** can be constructed from a plastic type material. The pressure regulator **202** is inserted into the retaining cup **300**. At this point, the fastening device **303** is closed around the rim **302** as shown by the arrows **316, 318** and **320** so that portions of the rim **302** sit within the slots **307, 309**. Additionally, locking tab **312** would be inserted into the recess **314** to secure the regulator **202** in place. This is a particularly good design for high pressure environments.

Many modifications and variations are apparent from the foregoing description of the invention and all such modifications and variations are intended to be within the scope of the present invention.

WHAT IS CLAIMED IS:

1. A device for attaching a fuel pressure regulator having a fuel communication bore to a non-metallic fuel rail, comprising:

a non-metallic retention number directly molded to the end of the fuel rail, said member provided with a fuel communications bore; and

a fastening device for securely fastening the fuel pressure regulator to said non-metallic retention member allowing communication between the fuel communication bore of the fuel pressure regulator and fuel communications bore.

2. The device in accordance with claim 1, wherein said non-metallic retention member includes at least one fastening bore and said fastening device comprises a bracket directly affixed to the fuel pressure regulator provided with at least one hole and a fastening member passing through said fastening bore of said non-metallic retention member and said hole of said bracket, thereby securing the fuel pressure regulator to said non-metallic retention member.

3. The device in accordance with claim 2, wherein said fastening bore is threaded and said fastening member is a threaded screw.

4. The device in accordance with claim 2, wherein said fastening bore is initially unthreaded and said fastening member is a thread forming screw.

5. The device in accordance with claim 2, wherein said fastening members is a single flexible barb.

6. The device in accordance with claim 2, wherein said fastening member comprises a band having first and second ends and further comprising flexible barbs connected to said first and second ends of said barb.

7. The device in accordance with claim 6, wherein said barb is constructed from non-metallic material.

8. The device in accordance with claim 1, wherein said non-metallic retention member includes a recessed interior section and said fastening device includes a bracket directly affixed to the fuel pressure regulator wherein said fastening device retains said brackets within said interior section of said retention member when the fuel pressure regulator is fastened to said non-metallic retention member.

9. The device in accordance with claim 8, wherein said fastening device further includes a forked clip having first and second legs, each of said legs provided with retaining tabs.

10. The device in accordance with claim 9, wherein said non-metallic retention member further comprises two pairs of slots, wherein each of said legs of said forked clip passes through one of said pairs of slots to fasten the fuel pressure regulator to said non-metallic retention member.

11. The device in accordance with claim 9 wherein said forked clip includes a top portion bridging said first and second legs angularly offset from the plane of said first and second legs.

12. The device in accordance with claim 10 wherein said forked clip includes a top portion bridging said first and second legs angularly offset from the plane of said first and second legs.

13. The device in accordance with claim 8, wherein said interior section of said non-metallic retention member includes a first slot provided with a bottom support member and a second slot provided with a top ceiling member, wherein said bracket member is inserted into both said first slot and said second slot when the fuel pressure regulator is fastened to said non-metallic retention member.

14. The device in accordance with claim 13, wherein said non-metallic retention member includes at least one fastening bore and said bracket is provided with at least one hole, and said fastening device further includes a fastening member passing through said fastening bore of said non-metallic retention member and said hole of said bracket, thereby securing the fuel pressure regulator to said non-metallic member.

15. The device in accordance with claim 14, wherein said fastening member is a flexible barb.

16. The device in accordance with claim 1, wherein said non-metallic retention member is provided with a plurality of spaced ribs and said fastening device includes a rotatable cap provided with a plurality of protuberances on its inner surface, each of said protuberances interacting with one of said spaced ribs to securely fasten the fuel pressure regulator to said non-metallic retention member.

17. The device in accordance with claim 1, wherein said non-metallic member is provided with at least one slot extending around its periphery and further wherein said non-metallic retention member includes a recessed interior section and said fastening device includes a forked clip having first and second legs, each of said legs provided with retaining tabs.

18. The device in accordance with claim 17, wherein each of said retaining tabs extend from the side surface of each said leg and deflect in the plane of said clip when said retaining tabs extend through said slot to retain the fuel pressure regulator in said non-metallic retention member.

19. The device in accordance with claim 17, wherein each of said retaining tabs extend from the end of each of said legs and deflect transverse to the plane of said clip when said retaining tabs extend through said slot to retain the fluid pressure regulator in said non-metallic member.

20. The device in accordance with claim 1, wherein said non-metallic member is provided with at least one slot extending around its periphery and further wherein said non-metallic retention member includes a recessed interior section and said fastening device includes a forked clip having first and second legs joined together by a shoulder element, said shoulder element provided with a retaining tab which deflects transverse to the plane of said clip to retain the fuel pressure regulator to be attached to the fuel rail.

21. The device in accordance with claim 1, wherein said non-metallic retention member is provided with a rim surrounding its periphery and said fastening device includes a plurality of deflectable tabs on its outer surface for retaining the fuel pressure regulator with said non-metallic retention member.

22. The device in accordance with claim 1, wherein said non-metallic retention member is provided with a rim surrounding its periphery and said fastening device includes a clip having a first member provided with a first interior slot and a second member provided with a second interior slot, said first and second members connected together by a living hinge.

23. The device in accordance with claim 22, wherein said fastening device includes a first latching device connected to said first member and a second latching device connected to said second member.

24. A method of securing a fuel pressure regulator having a bracket affixed thereto to a non-metallic fuel rail comprising:

molding a non-metallic retention member to one end of the fuel rail, said retention member provided with a recessed interior section including a first slot provided with a bottom support member and a second slot provided with a top ceiling member;

rotating the fuel pressure regulator in a first direction until a first end of the bracket is above the top of said first slot and a second end of the bracket is below the bottom of said second slot,

inserting the fuel pressure regulator into said recessed interior section such that the first end of the bracket is over said first slot and the second end of the bracket is under said second slot;

rotating the fuel pressure regulator in a second direction opposite said first direction allowing the first end of the bracket to enter said first slot and the second end of the bracket to enter said second slot; and

fastening the fuel pressure regulator to said non-metallic retention member.

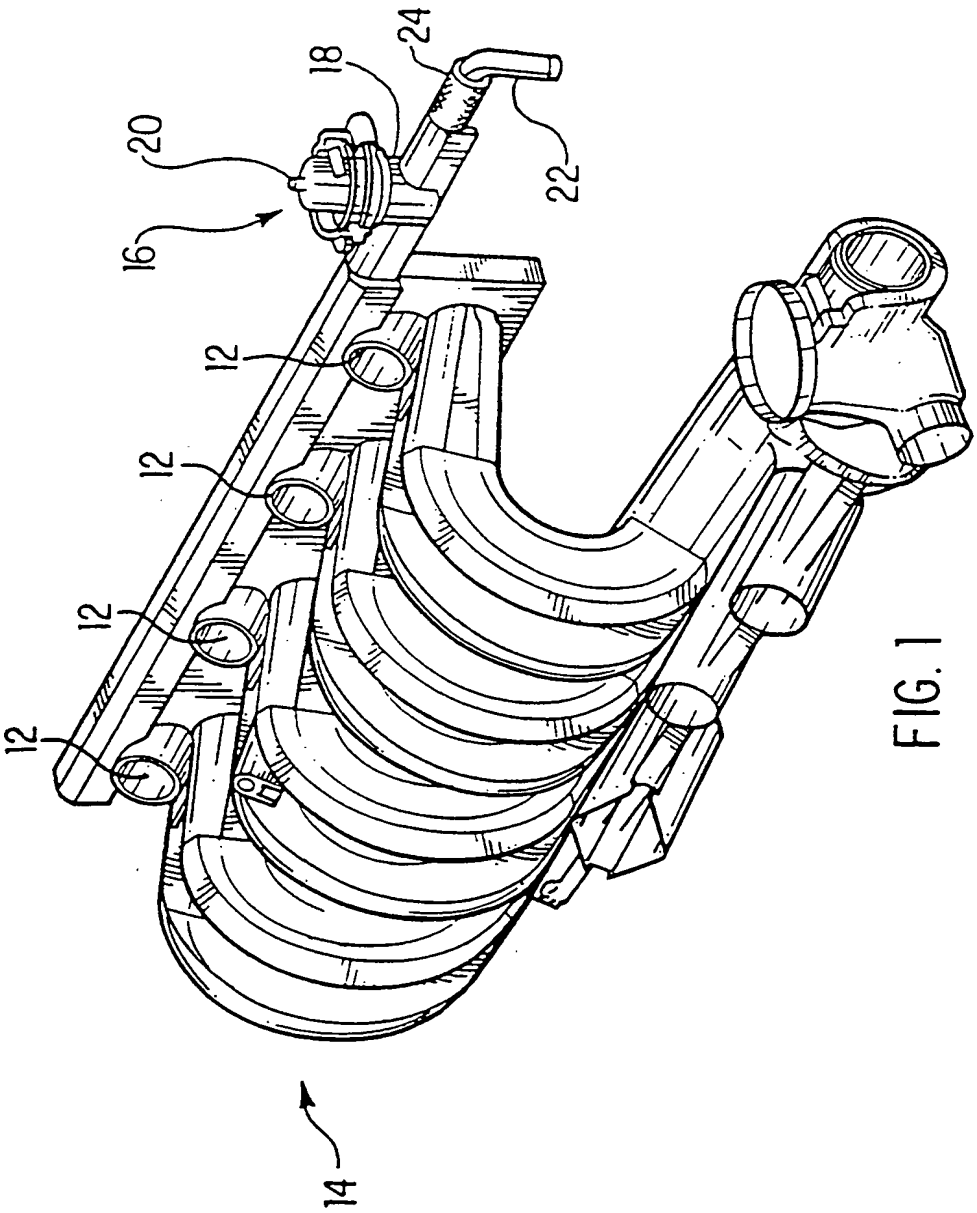

FIG. 1

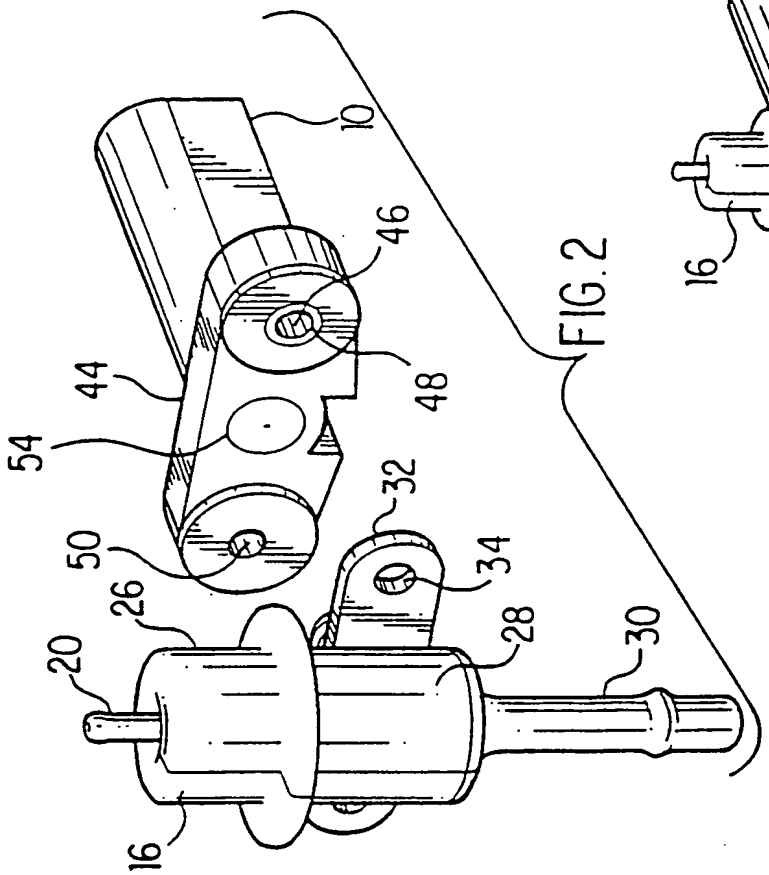

FIG. 2

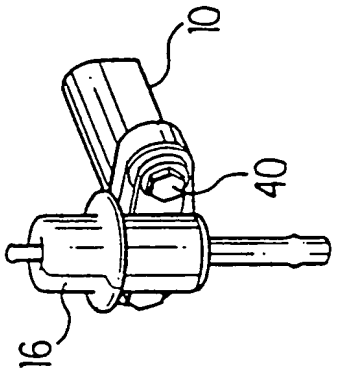

FIG. 3

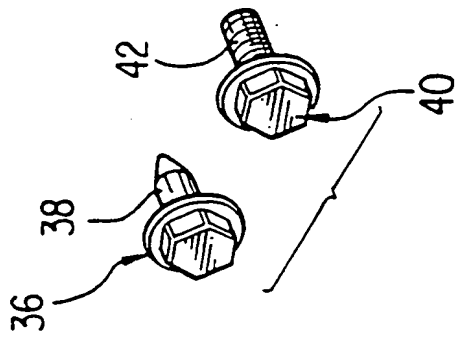

FIG. 4

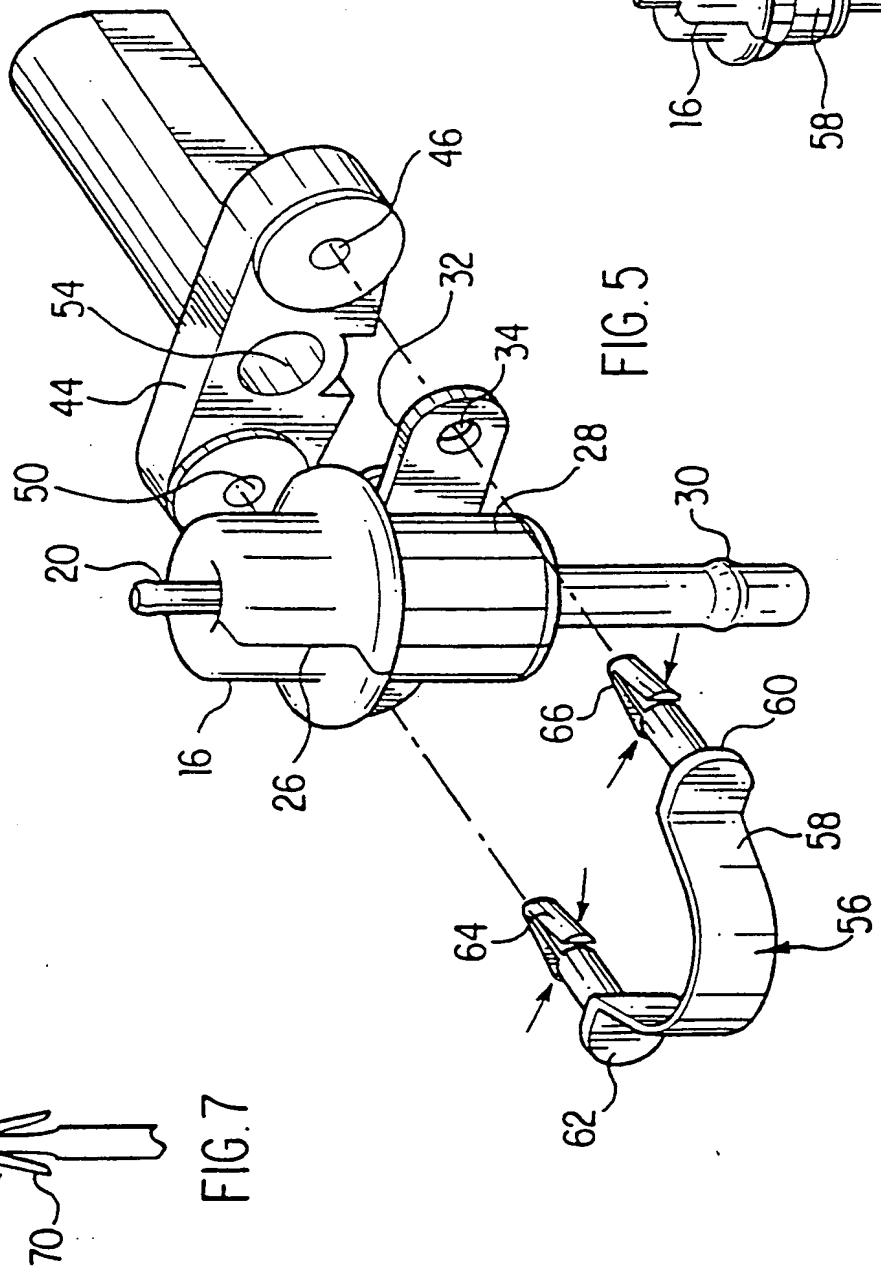

FIG.5

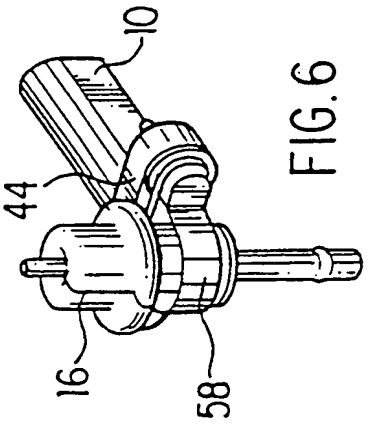

FIG.6

FIG.7

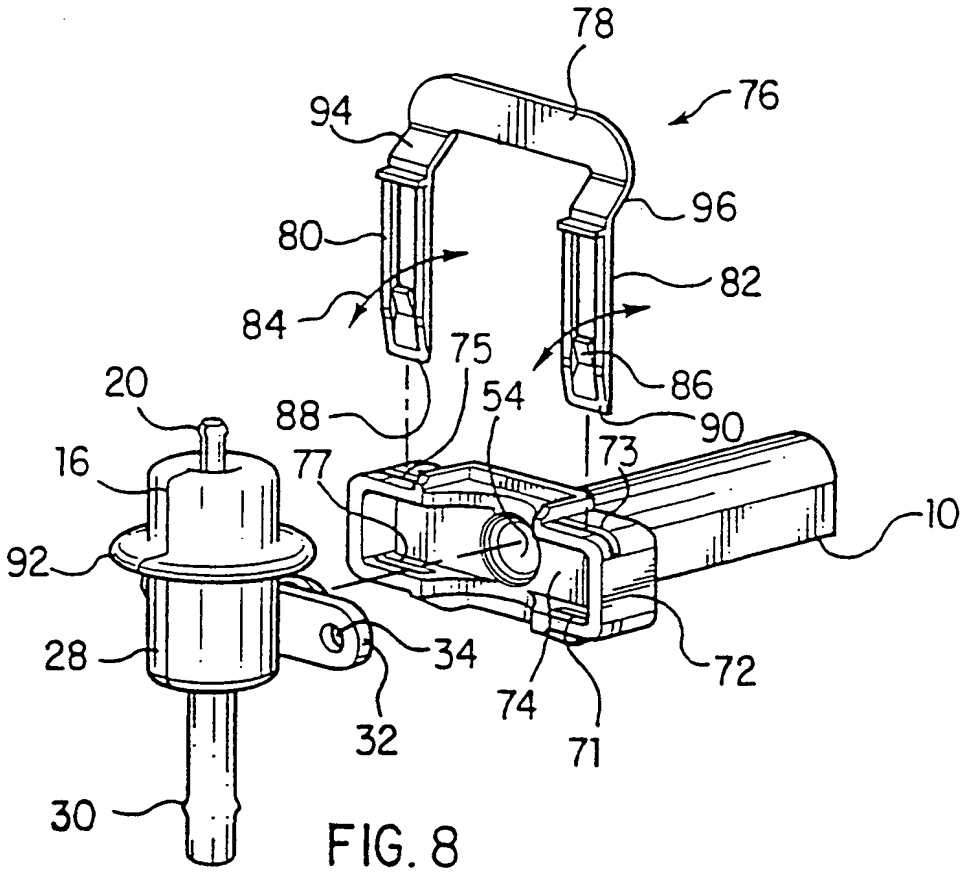
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FIG. 8

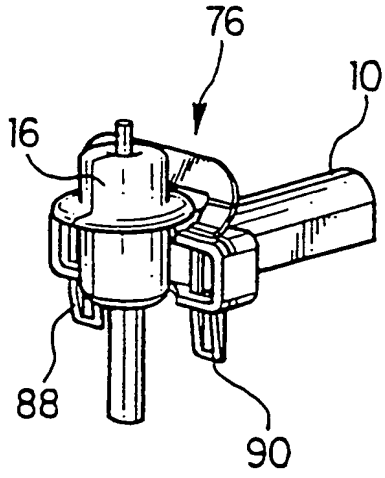
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FIG. 9

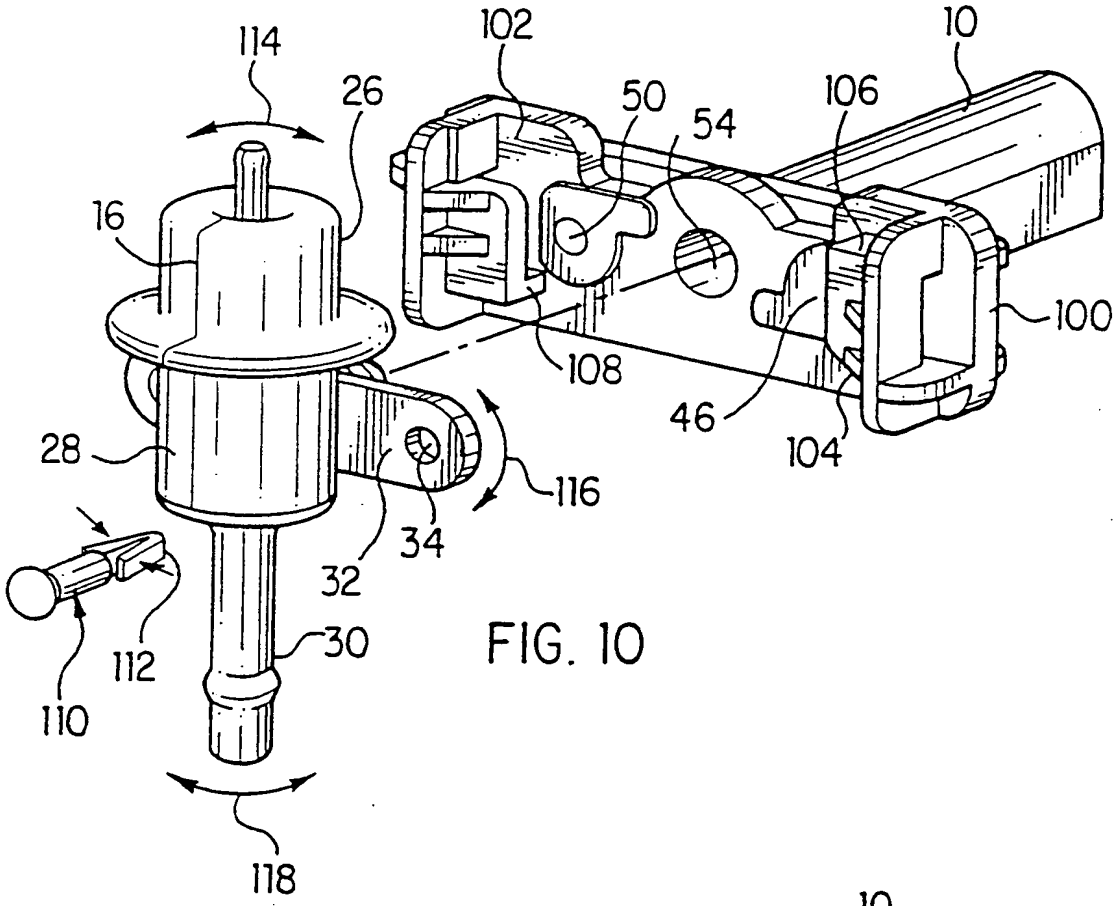
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FIG. 10

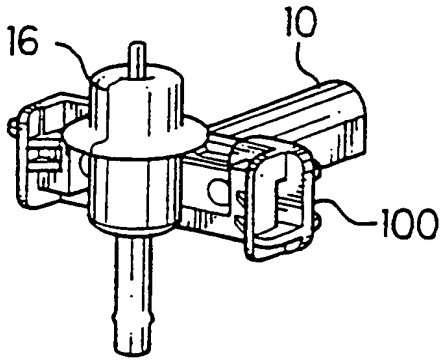
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FIG. 11

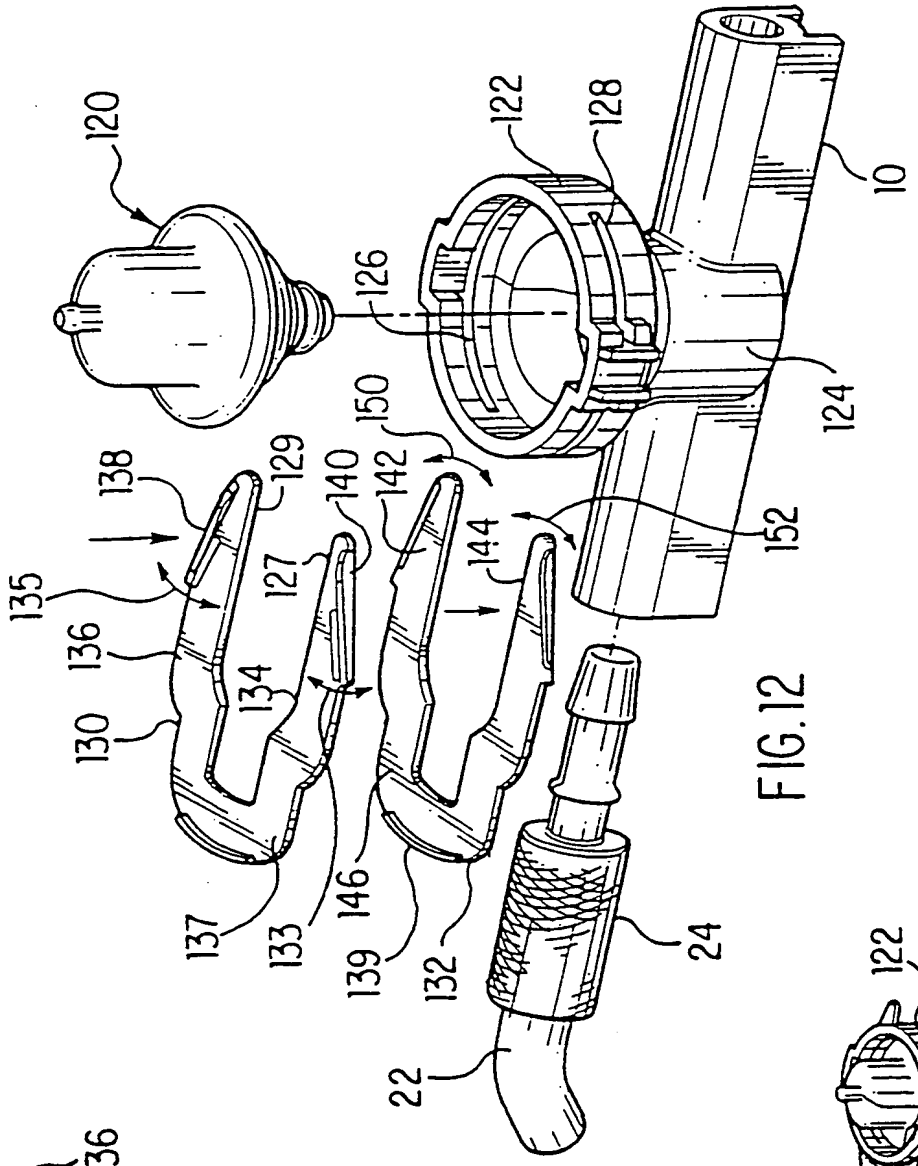

FIG. 12

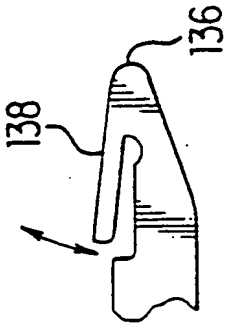

FIG. 13

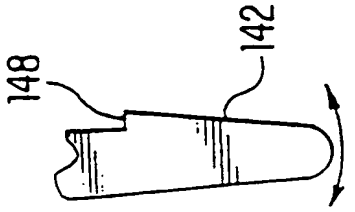

FIG. 14

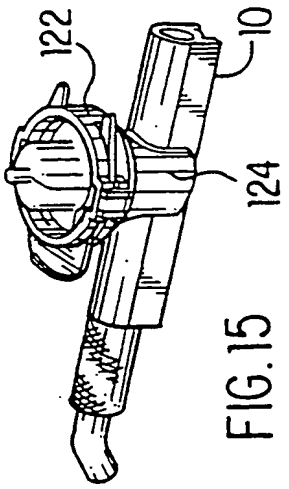

FIG. 15

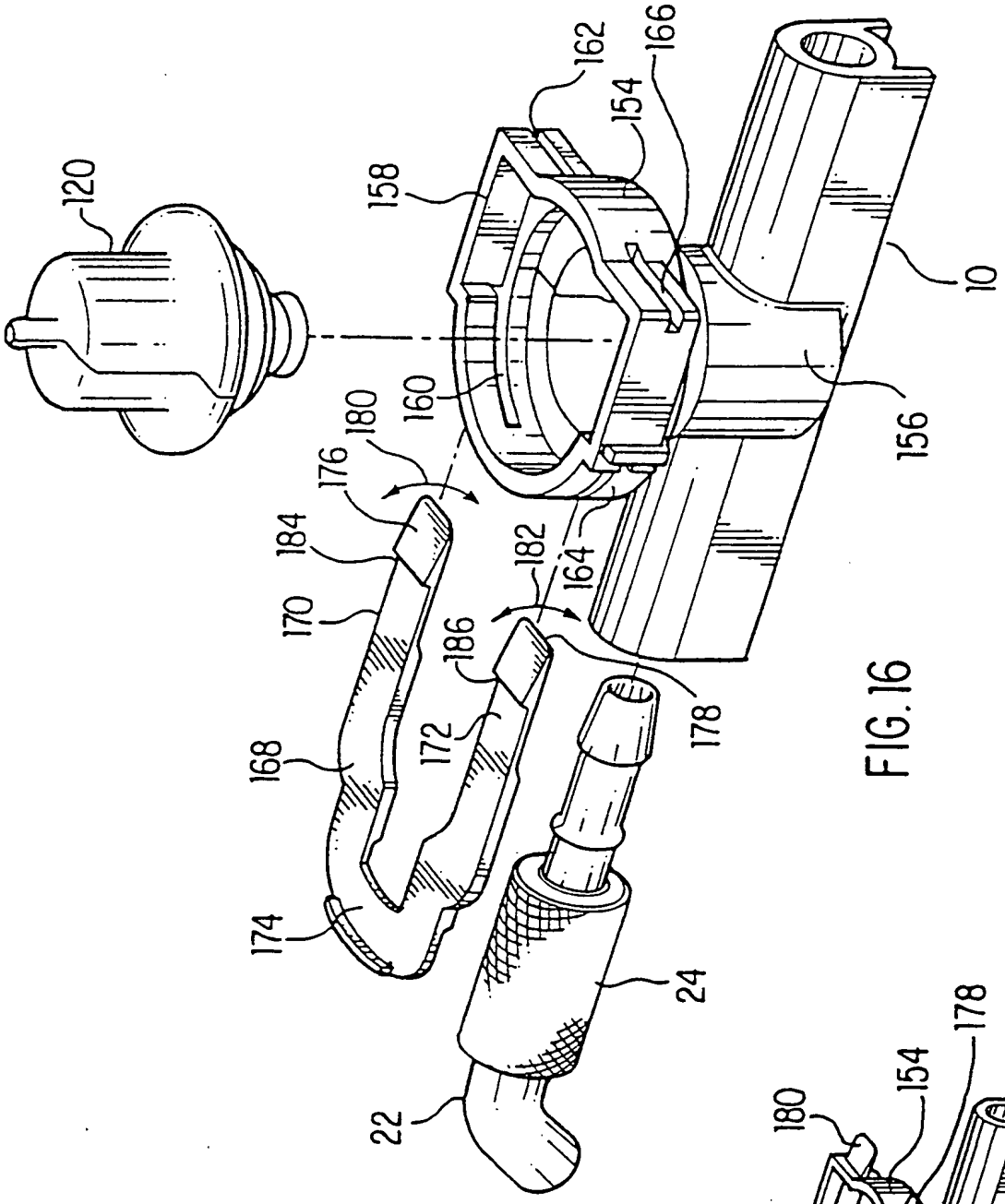
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FIG. 16

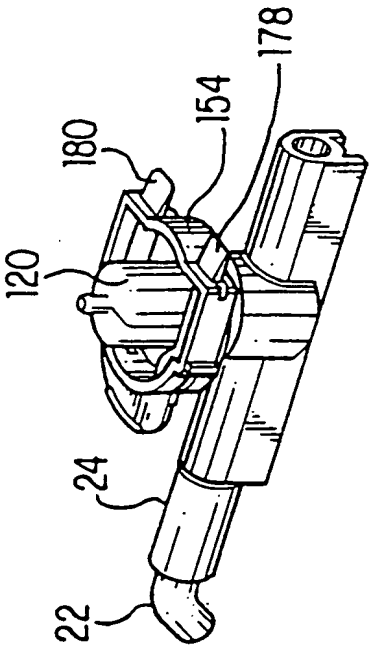
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FIG. 17

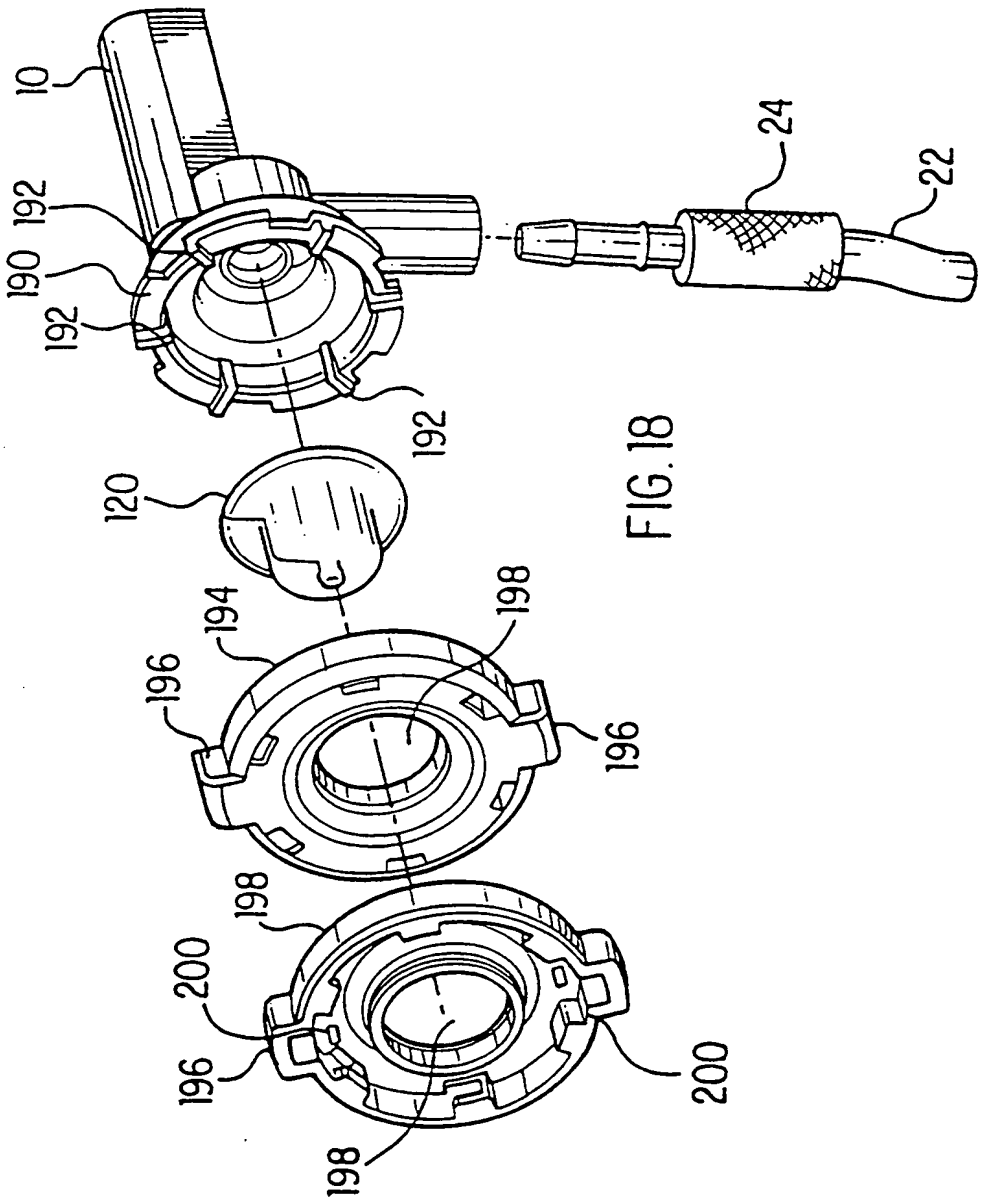

FIG. 18

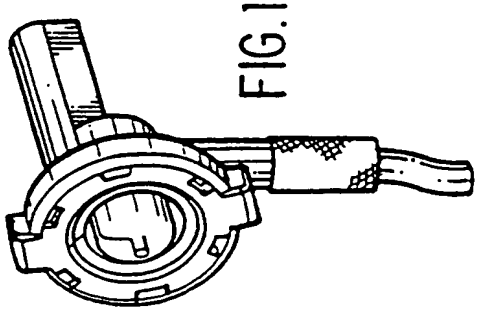

FIG. 19

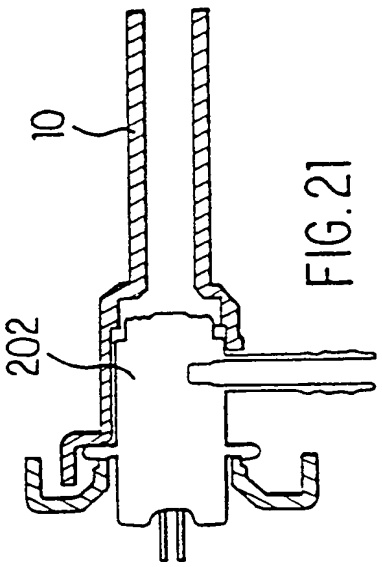

FIG.21

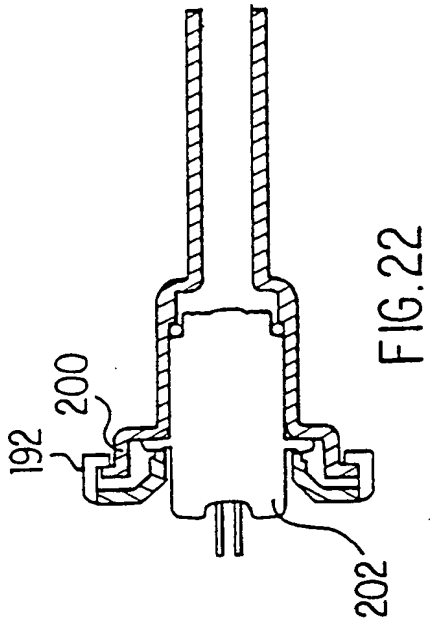

FIG.22

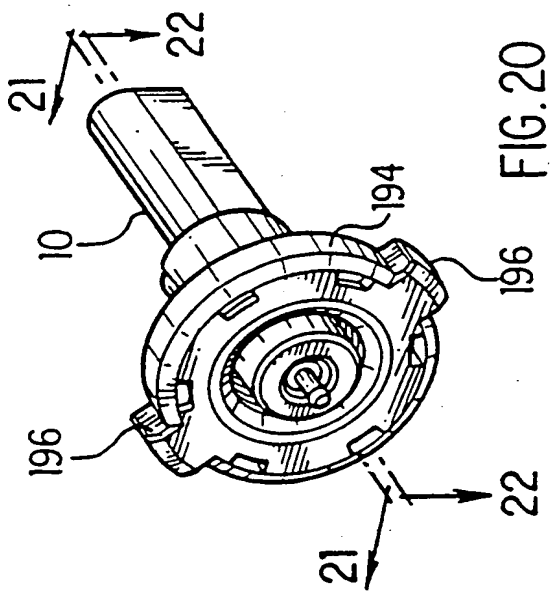

FIG.20

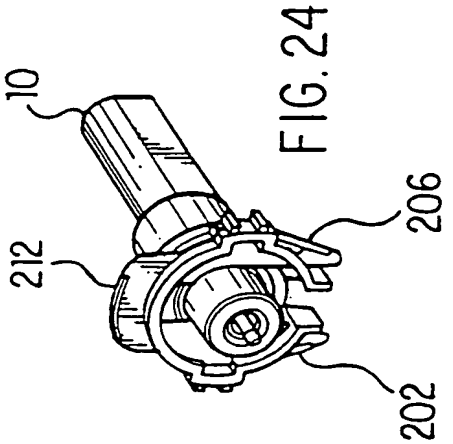

FIG. 24

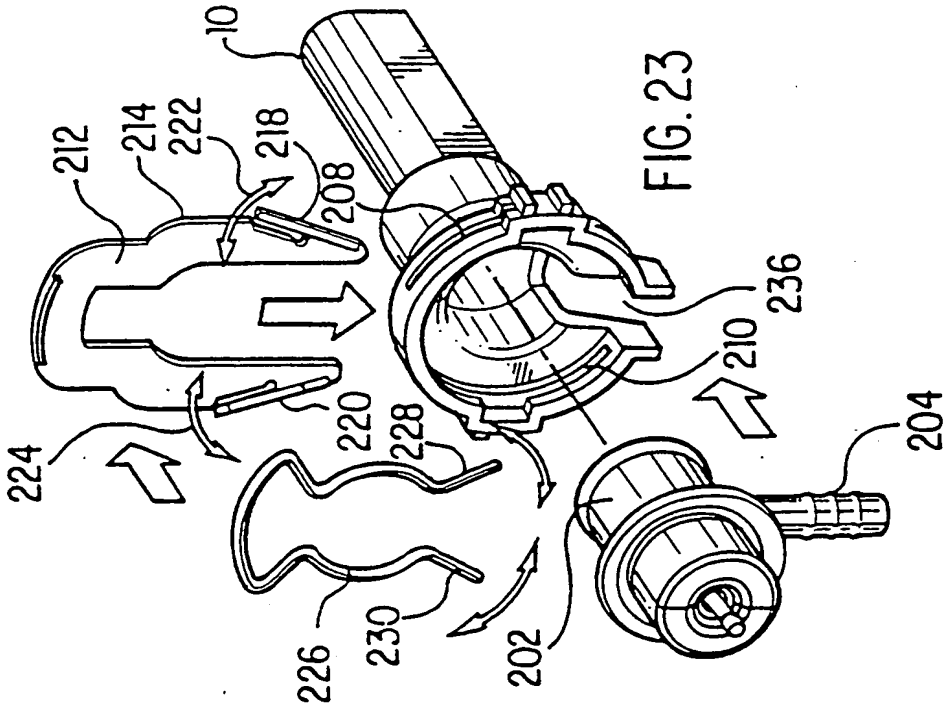

FIG. 23

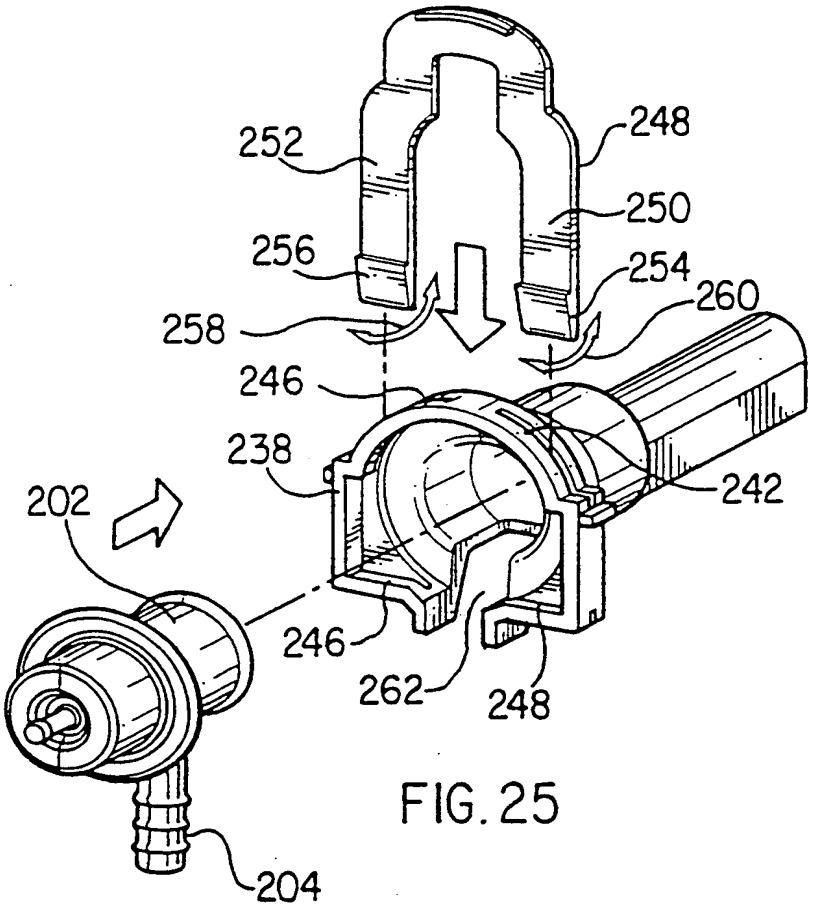
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FIG. 25

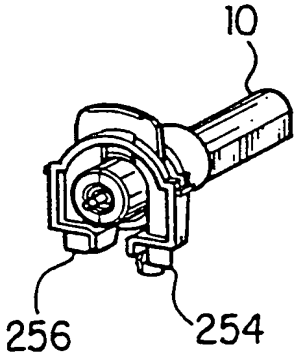
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FIG. 26

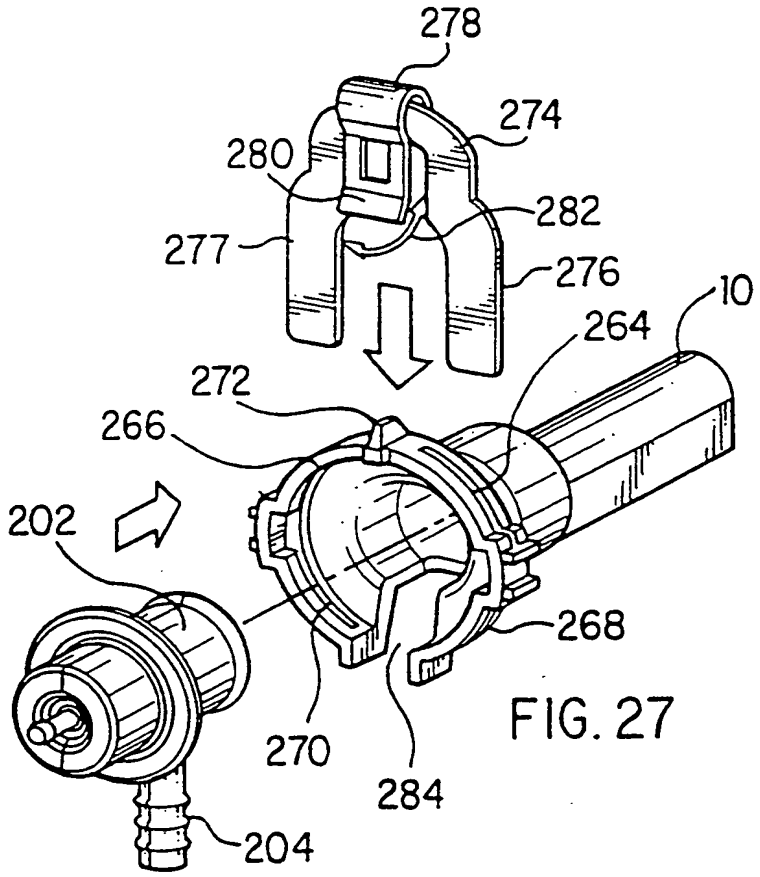

FIG. 27

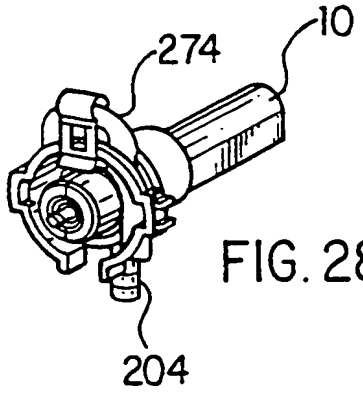

FIG. 28

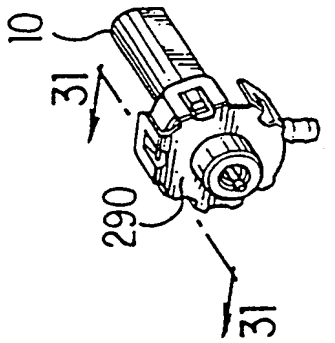

FIG.30

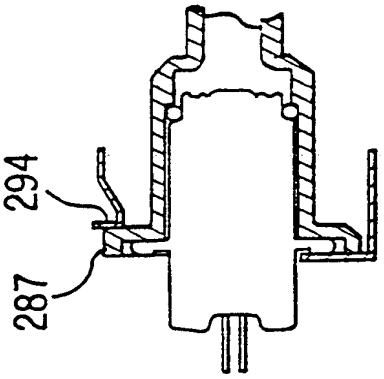

FIG.31

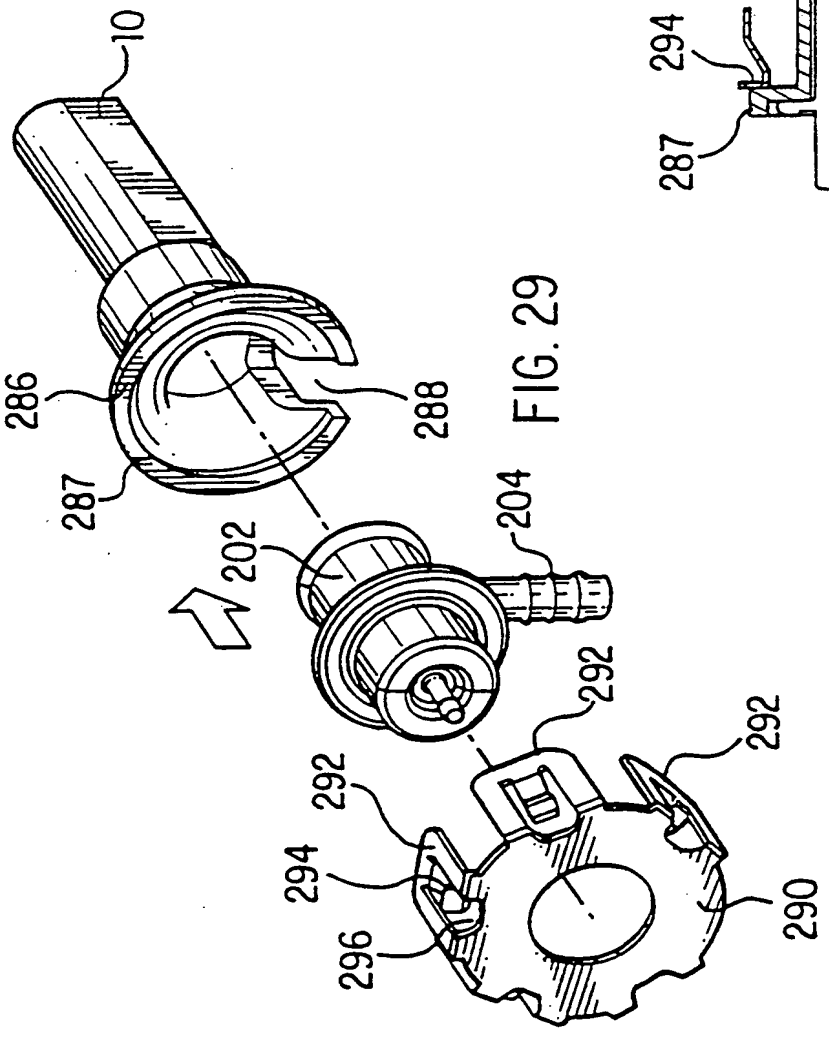

FIG. 29

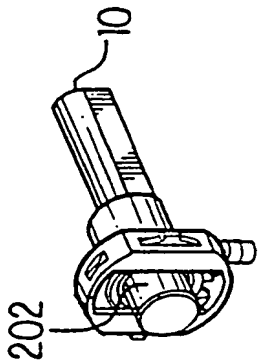

FIG. 33

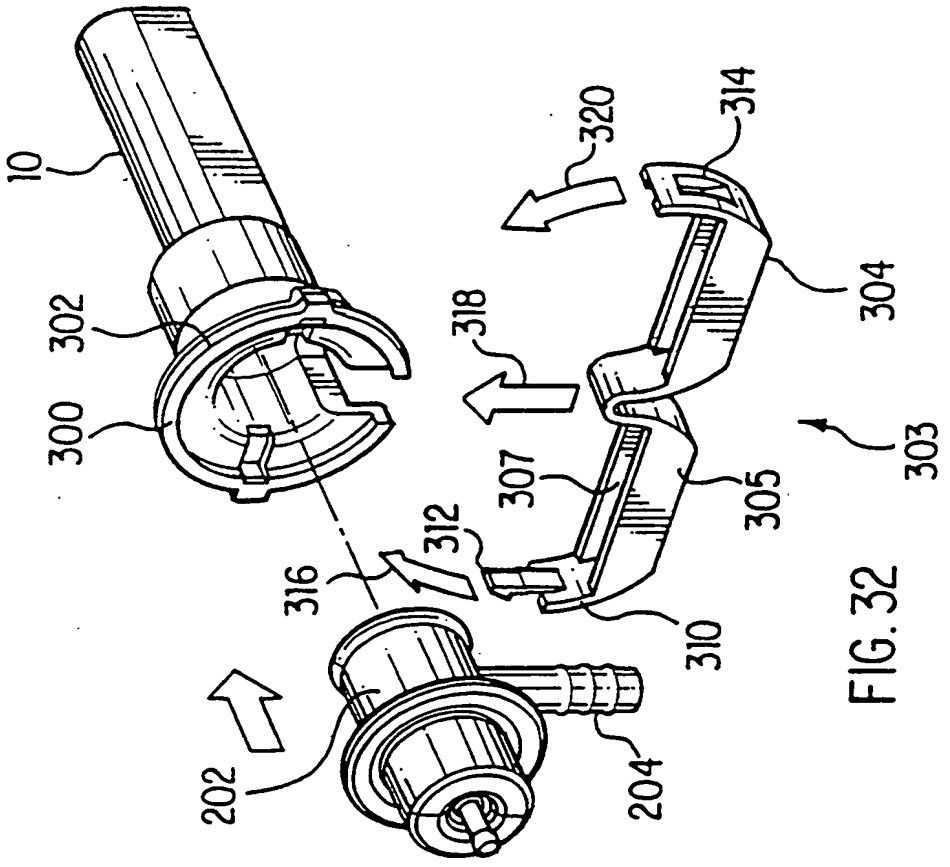

FIG. 32

INTERNATIONAL SEARCH REPORT

Inter[illegible]al Application No
PCT/CA 98/00681

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F02M69/54 F02M69/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	FR 2 637 021 A (PEUGEOT ;CITROEN SA (FR)) 30 March 1990 see page 3, line 33 - page 7, line 28; figures	1,8-11 2,3,12, 16-18, 20,21
Y	DE 37 28 980 A (BOSCH GMBH ROBERT) 9 March 1989 see column 2, line 44 - column 4, line 52; figures	2,3
Y	DE 36 07 811 A (BOSCH GMBH ROBERT) 10 September 1987 see column 5, line 32 - line 63; figures 5-8	12

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of theinternational search	Date of mailing of the International search report
16 October 1998	27/10/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Sideris, M

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INTERNATIONAL SEARCH REPORT

Inter ıal Application No
PCT/CA 98/00681

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category ³	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 756 289 A (ROCK JEFFREY A ET AL) 12 July 1988	16
A	see column 3, line 45 - line 50; figure 3	13,24
Y	US 4 993 390 A (ONO TAKASHI ET AL) 19 February 1991 see abstract; figure 3	17,18
Y	US 5 390 638 A (HORNBY MICHAEL J ET AL) 21 February 1995 cited in the application	20
A	see column 4, line 43 - column 6, line 54 see column 8, line 12 - line 40; figures 35-37,39	5
P,Y	US 5 682 857 A (BRIGGS PAUL F ET AL) 4 November 1997 see abstract; figures 1-3	21
A	DE 40 07 436 A (BAYERISCHE MOTOREN WERKE AG) 12 September 1991 see column 2, line 39 - line 51; figure 3	1
A	US 5 501 195 A (HALL BRYAN C) 26 March 1996 see column 5, line 33 - line 43; figure 5	22
A	WO 92 14051 A (SIEMENS AG) 20 August 1992	

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INTERNATIONAL SEARCH REPORT

...ormation on patent family members

Inter ...al Application No
PCT/CA 98/00681

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